# An Analysis of the July 8, 1999 Las Vegas Valley Flash Flood Event Using the Weather Event Simulator (WES)

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#### Introduction

The Las Vegas Valley experienced one of its worst flash flood events on July 8, 1999. Nocturnal thunderstorms, an unusual scenario for southern Nevada, developed across the southern portions of Lincoln and Nye Counties during the early morning hours of July 8. Shortly after daybreak, the thunderstorm activity initiated across the higher terrain of Clark County. As the morning progressed, the cells intensified over the western foothills and began moving slowly to the east and into the western portions of the valley. By 930 AM PDT (1630Z), scattered thunderstorms began to develop across the entire Las Vegas valley. The thunderstorms across the western portion of the valley began to merge with the cells over the metropolitan area between 1000 AM (1700Z) and 1100 AM PDT (1800Z). These thunderstorms produced extremely heavy rainfall rates averaging 1.5 to 3.0 inches per hour and combined with earlier runoff, which flows from west to east through the valley, to produce extensive flash flooding across the Las Vegas metropolitan area. Total rainfall across the Las Vegas valley averaged 1.0-1.5 inches (Fig. 1) with the majority of rainfall occurring in only 60 to 90 minutes. Two ALERT gauges reported total rainfall in excess of 3 inches with short duration rates in excess of 5 inches per hour.

## **Synoptic Summary**

The July 8, 12Z sounding at Desert Rock (KDRA), approximately 60 miles northwest of Las Vegas, indicated significant deep-layer moisture, instability and very weak flow (Fig. 2). Precipitable water values were increasing the previous few days and reached 1.68 inches by the morning of July 8 via the Desert Rock sounding. The Desert Rock sounding also denoted a lifted index of -6.4 without any modification and the Convective Available Potential Energy (CAPE) was 2268 J/Kg. The 12Z ETA analysis on July 8, indicated CAPE values in excess of 1000 J/Kg across much of southern Nevada (Fig. 3). The flow was very weak at all levels on the 12Z Desert Rock sounding and produced a 0-6 km average wind of 062 at 1 knot and a 0-3 km storm motion of 140 at 0 knots (Fig. 2). Low-level southerly flow was dominant across Arizona and into southern Nevada continuing to supply significant moisture to the region. The surface dew points in Las Vegas were in the mid 60s throughout the morning and were in the upper 60s to lower 70s to the south of Las Vegas. In addition, the 12Z sounding at Yuma indicated a precipitable water value of 2.01 inches. Based on the sounding and the regional environment, it is evident that any storms that would develop would be very efficient rainfall producers and would have very little movement.

An analysis of the 500 mb and 700 mb upper air charts depicts an inverted trough along the Nevada/Arizona border southward along the eastern portions of the Baja of California at 12Z on July 8. A deformation zone was present in the 12Z ETA model analysis in the 500 mb heights and winds over southern Nevada at 12Z (Fig. 4). This trough and an associated deformation zone at 500 mb, provided the support to initiate the showers and thunderstorms across southern Nevada and northwest Arizona during the early morning hours on July 8. This trough pushed slowly to the west and into the Las Vegas valley during the morning. The impact of the trough is discernible in the 6-hour (18Z) forecast of upward forcing in the 700-400 mb layer Omega field (Fig. 5) from the 12Z run of the ETA over southern Nevada. The 12Z ETA also

indicated an enhanced area of absolute vorticity at 500 mb from 18Z through 00Z across the same region.

### **Radar Summary**

Between 800 AM (1500Z) and 900 AM PDT (1600Z), thunderstorms were located mainly over the higher terrain of Clark County in the Spring Mountains to the west and Sheep Range to the north of Las Vegas. By 930 AM PDT (1730Z), showers and thunderstorms began to move into the northern and western portions of the Las Vegas valley. Scattered thunderstorms began to develop across the southern portions of the Las Vegas valley and became more organized by 1000 AM PDT (1700Z). The thunderstorms to the west of the valley moved off the higher terrain and began to merge with the southerly cells around 1030 AM (1730Z). This merging took place mainly over the Las Vegas metropolitan area. The merging cells produced extremely heavy rainfall between 1100 AM (1800Z) and 1200 PM PDT (1900Z) as depicted in the KESX 1832Z one hour radar estimate and 1832Z composite radar image (Fig. 6). This heavy rain was combined with the arrival of heavy runoff from the higher terrain to the west and produced a devasting one-two punch to the metro area. Rainfall rates of 1.5 - 2.0 inches per hour were common with these storm with several ALERT gages reporting shorter durations rates in excess of 4.0 inches per hour. Storm totals averaged 1.5 to 3.0 inches with the maximum amount of 3.23 inches occurring at ALERT station 4624 (Paradise Rd. 1/4 mile north of Windmill Rd. - Fig 1).

#### **Discussion**

Prior to the flash flood event, multiple statements were issued to give the population a heads up to the possibility of a flash flood threat. A special weather statement highlighting the flash flood potential for southern Nevada was issued during the afternoon of July 7 and was followed by a flash flood watch at 400 AM PDT (1100Z). During July 8, four flash flood warnings and four flash flood statements were issued for southern Nevada. When the rain and flooding had ceased, the Las Vegas valley received 35%-70% (1.5 to 3.0 inches) of its normal annual rainfall in only 60 to 90 minutes. Preparing, planning, forecasting and dealing with a hydrologic problem as the July 8, 1999 event is an extremely difficult task and highlights the necessity of community collaboration with regards to city officials, emergency management, media and the general public. In a location such as Las Vegas, the fast growth and transient nature of the population adds substantially to this challenge.

Much of the Las Vegas valley was under a flash flood warning at 1115 AM PDT (1815Z) on the morning of July 8. Although the flash flood potential was well advertised, many people were unprepared for the rapid and extensive amount of flash flooding, as over 200 swift-water rescues were performed by the Las Vegas and Clark County Fire Departments. The resulting runoff from these rains caused widespread street flooding and record flows in normally dry washes and flood control district detention basins (Sutko, 1999).

#### References

Sutko, Timothy, 1999: Rainfall Event Report. Clark County Regional Flood Control District Report.

Las Vegas Rainfall 0.43" \* 0.47 • 1.22" 0.28 • 0.39" 1.65\*\* 0.87\* 0.83" 1.61" 1.77\* 1.65" • 2.60 2.05"

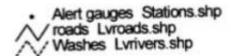


Fig. 1. Las Vegas valley Rainfall Totals for July 8, 1999

Figure 2

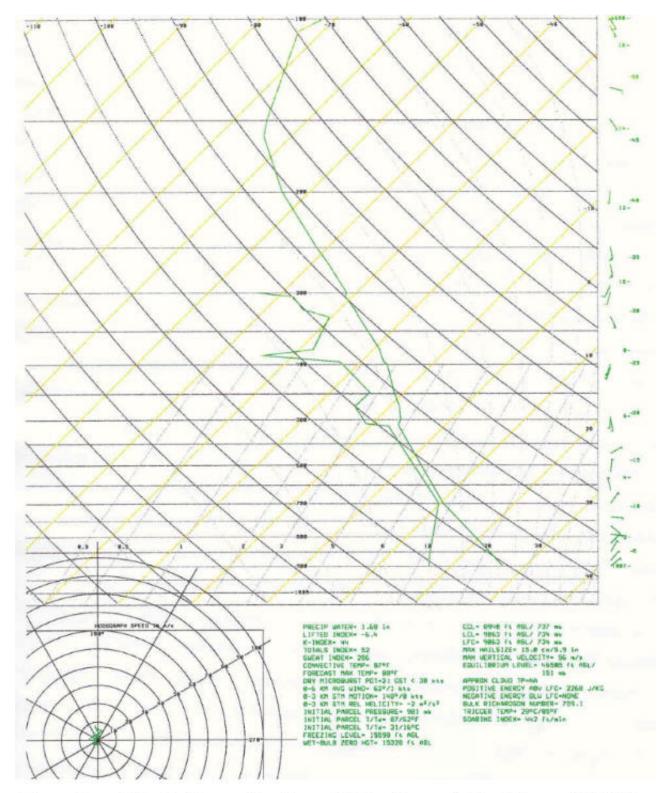


Fig. 2. 12Z Radiosonde from KDRA (Desert Rock) on 7/8/99.

Figure 3

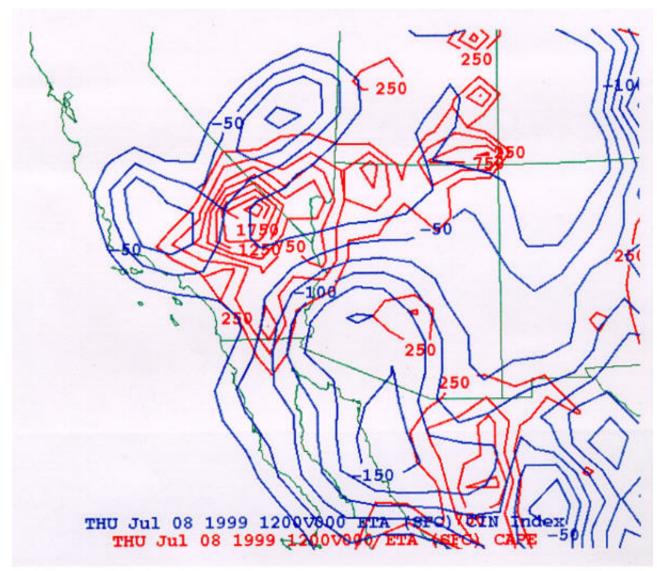


Fig. 3. 12Z ETA 0-hr analysis of CAPE and CIN on 7/8/99.

Figure 4

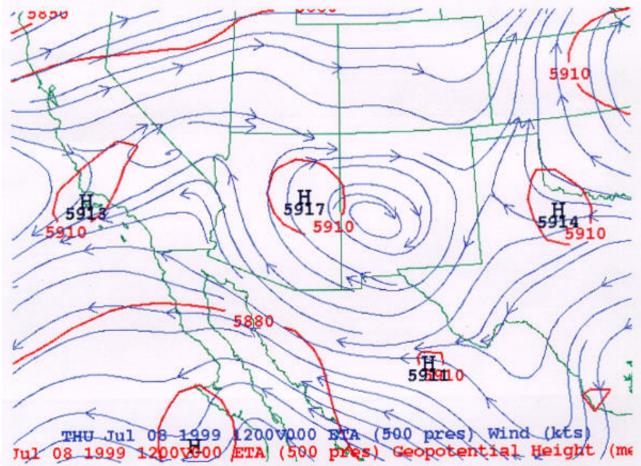


Fig. 4. 12Z ETA 00-hr analysis of 500 mb geopotential heights and winds on 7/8/99.

Figure 5

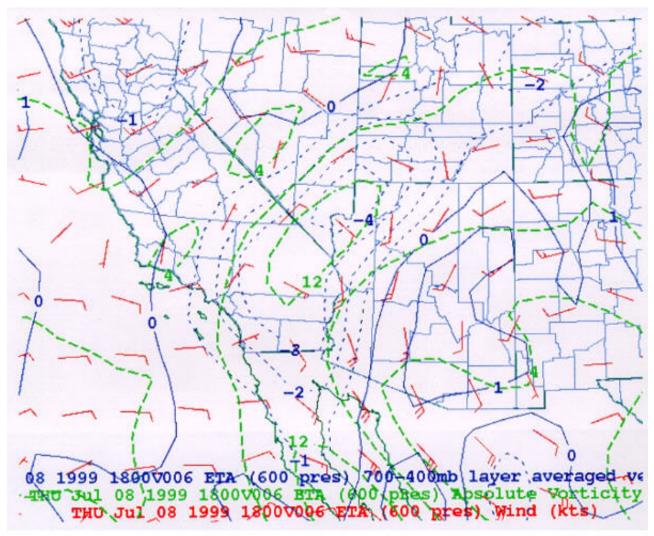


Fig. 5. 12Z ETA 6-hr forecast (18Z) of 700-400 mb omega, 600 mb absolute vorticity, and 600 mb winds

Figure 6

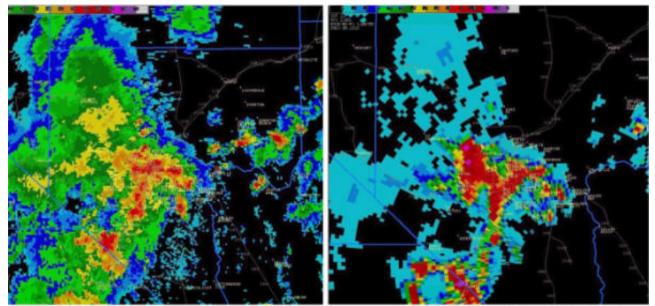


Fig. 6. KESX Radar Composite 1832Z (left) and KESX One-Hour Precip. Estimate (1832Z).